

## RADIO-TAGGED PACIFIC GOLDEN-PLOVERS: FURTHER INSIGHT CONCERNING THE HAWAII-ALASKA MIGRATORY LINK

OSCAR W. JOHNSON,<sup>1,8</sup> COREY D. ADLER,<sup>2,6</sup> LEE ANNE AYRES,<sup>3</sup>  
MARY ANNE BISHOP,<sup>4</sup> JODI E. DOSTER,<sup>2,7</sup> PATRICIA M. JOHNSON,<sup>1</sup>  
RONALD J. KIENHOLZ,<sup>5</sup> AND SUSAN E. SAVAGE<sup>2</sup>

**ABSTRACT.**—We radio-tagged 55 Pacific Golden-Plovers (*Pluvialis fulva*) in spring 2001–2003 on wintering grounds in Hawaii. Following their northward migration (most birds deserted winter territories in late April), we relocated 15 golden-plovers in three regions of Alaska: Copper River Delta, King Salmon, and Kotzebue. One individual made the transpacific flight from Oahu to the Alaska Peninsula in a minimum time of 70 hr at a minimum flight speed of 56 km/hr. Our findings, together with earlier records, indicate a major Hawaii-Alaska migratory connection for this species, and suggest that plovers wintering on Oahu nest throughout the known Alaska breeding range. Post-breeding, 84% of the sample birds returned to Oahu and reoccupied their previous winter territories. Received 21 November 2003, accepted 10 June 2004.

The first investigations of radio-tagged Pacific Golden-Plovers (*Pluvialis fulva*) on the mid-Pacific flyway were conducted in 1996 and 1999. In these studies, birds from wintering populations on Oahu, Hawaii, were found after transoceanic spring migration at three locations in Alaska (Johnson et al. 1997, 2001a). While migrating northward, one of the plovers spent time at the Copper River Delta stopover and then proceeded on to breeding grounds in the Nushagak River drainage northwest of Lake Iliamna; others were detected (presumably nesting) in the Nushagak River area and on the Yukon-Kuskokwim Delta. Here, we present additional telemetry findings that further clarify spring movements and destinations of plovers in Alaska. We also report the post-breeding return rates to wintering territories in Hawaii.

### METHODS

Over three spring seasons, we captured 55 plovers on Oahu—20 each in 2001 and 2002, and 15 in 2003. The birds (24 adult males, 22 adult females, 3 first-year males, and 6 first-year females) were caught mostly during the third week of April with mist nets on lawn areas at three wintering ground study sites: National Memorial Cemetery of the Pacific, Hickam Air Force Base, and Bellows Air Force Station. These are the same sites where plovers were radio-tagged in previous investigations (Johnson et al. 1997, 2001a). We uniquely color-banded each plover and glued a 1.65 g, 60-day life span transmitter (Holohil Systems, Carp, Ontario) to feather stubs on the lower back (see Warnock and Warnock 1993). Such attachment was temporary, as radios would be expected to fall off during summertime prebasic molting on the tundra (Johnson and Connors 1996). Based on the weights of birds closest to migratory departure (mean = 173 g, range = 148–207 g,  $n = 18$ ; all captured on either 19 or 20 April, about 1 week pre-migration) plus comparable data from the same sites in other years (Johnson et al. 1997, 2001a; OWJ unpubl. data), the attached transmitters generally averaged less than 1% of total mass at migration. For additional information on capture, marking, and determination of sex and age, see Johnson et al. (1997, 2001a, 2001b).

All of the radio-tagged plovers defended specific winter territories on lawns at the study sites; thus, we could monitor them easily after

<sup>1</sup> Dept. of Ecology, Montana State Univ., Bozeman, MT 59717, USA.

<sup>2</sup> U.S. Fish and Wildlife Service, Alaska Peninsula/Becharof National Wildlife Refuge, P.O. Box 277, King Salmon, AK 99613, USA.

<sup>3</sup> U.S. Fish and Wildlife Service, Selawik National Wildlife Refuge, P.O. Box 270, Kotzebue, AK 99752, USA.

<sup>4</sup> Prince William Sound Science Center, P.O. Box 705, Cordova, AK 99574, USA.

<sup>5</sup> P.O. Box 503, Gallatin Gateway, MT 59703, USA.

<sup>6</sup> Current address: Alaska Coop. Fish and Wildlife Research Unit, Univ. of Alaska, Fairbanks, AK 99775, USA.

<sup>7</sup> Current address: P.O. Box 143, King Salmon, AK 99613, USA.

<sup>8</sup> Corresponding author; e-mail: owjohnson2105@aol.com

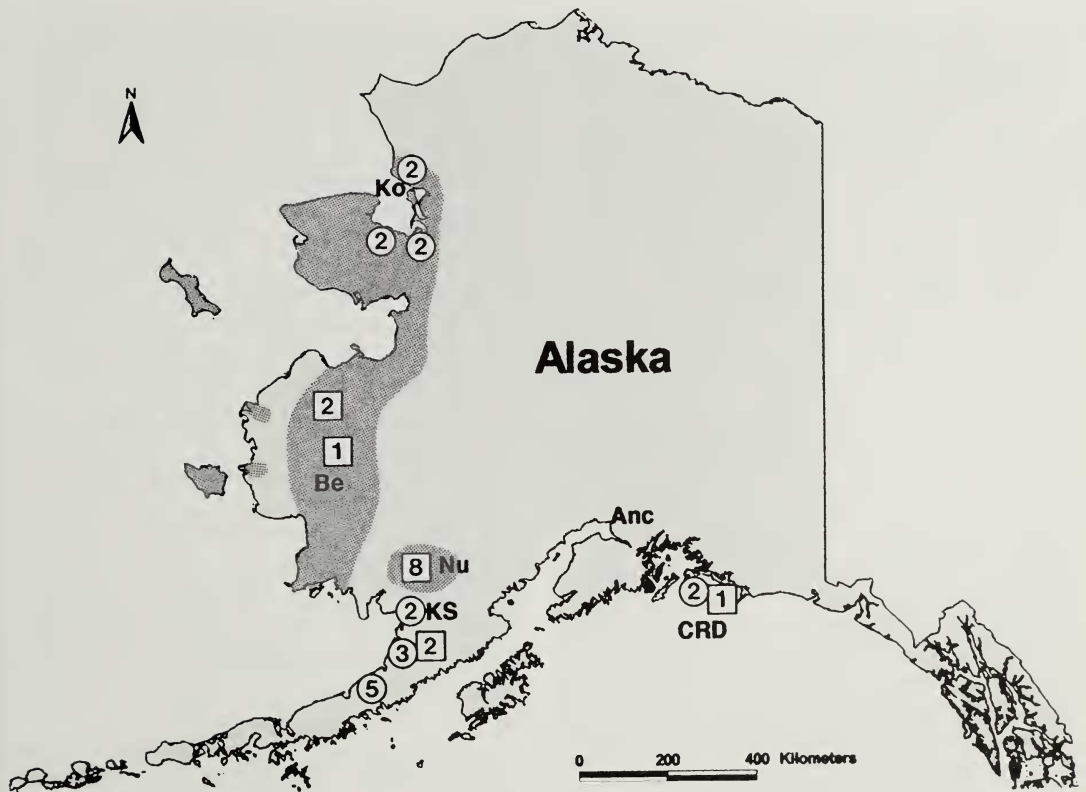


FIG. 1. Detections of radio-tagged Pacific Golden-Plovers (*Pluvialis fulva*) in Alaska. Numbers in circles represent the present study (2001–2003), numbers in squares show previous findings (Johnson et al. 1997, 2001a). Over all years, we recorded 32 detections of 28 birds. Four individuals made long-range movements following first detection (see text). Darker gray shading shows the approximate nesting range of *P. fulva* in Alaska. Abbreviations: CRD (Copper River Delta), Anc (Anchorage), KS (King Salmon), Nu (Nushagak River drainage), Be (Bethel), Ko (Kotzebue).

release. We checked for the presence of tagged birds several times a day (with a radio receiver and/or visually), and considered disappearance from a territory as an indicator of migration (Johnson et al. 1997, 2001a, 2001b). This plover is strongly site-faithful to winter territories from one season to the next (Johnson and Connors 1996, Johnson et al. 1997, 2001a, 2001b), which enabled determination of return rates in the fall.

In Alaska, we monitored radio frequencies in the Copper River Delta, King Salmon, and Kotzebue regions (Fig. 1) using fixed-wing aircraft equipped with VHF receiving antennae. Aerial surveys were conducted from late April to the third week of May at the Copper River Delta and King Salmon areas, and from mid-May to mid-June at Kotzebue. Surveys were typically coincident with other telemetry

projects involving the same aircraft. The areas traversed by monitoring flights were approximately as follows: Copper River Delta—coastal flats from Cordova to Controller Bay; King Salmon—Dillingham to Inlik, coastline to 10 km inland; Kotzebue—Kivalina to Deering, coastline to 30–50 km inland. There were 2–3 flights per season in the Kotzebue region. Monitoring efforts were more variable in the other areas: Copper River Delta—19 flights in 2001, 6 in 2002, 1 in 2003; King Salmon—11 flights in 2001, 7 in 2002, 2 in 2003. With the exception of the Copper River Delta, we recorded GPS coordinates whenever a radio-tagged plover was detected.

## RESULTS

During the 2001–2003 spring seasons, migratory departure (as indicated by disappear-

ance of birds from their winter territories) occurred from 17 April to 9 May, with almost all departures taking place in late April. Collectively, 44 of the 55 plovers (80%) departed from 22 to 29 April, 3 birds (5%) disappeared before 22 April, and 8 (15%) after 29 April. Much the same pattern (OWJ unpubl. data) was observed in our 1996 and 1999 studies, when 56 of 60 birds (93%) disappeared from 23 to 29 April, 1 bird (2%) before 23 April, and 3 birds (5%) after 29 April. Based on combined records from all plovers we have radio-tagged (65 males and 50 females in 1996, 1999, and 2001–2003), earlier departures were somewhat male-biased. Over all years, 97% of males and 82% of females had left their territories by 29 April; the last birds at our study sites each spring were typically females. There was no indication that radio-tagging delayed departures, as tagged and untagged birds deserted their territories at similar rates, and generally the last few individuals to leave were untagged. More females (10) than males (5) were relocated in Alaska from 2001 to 2003, but there was no statistical difference between the sexes ( $\chi^2 = 0.13$ ,  $df = 1$ ,  $P = 0.72$ ) when relocations in previous studies (Johnson et al. 1997, 2001a) were combined with the present sample. Over all years, 15 of 65 males and 13 of 50 females radio-tagged on Oahu were relocated in Alaska (Fig. 1).

The number of birds detected varied among years: nine in 2001, five in 2002, and one in 2003. Inter-year variation apparently resulted from the number of flights per season, survey timing (either too early or too late), lack of plover-specific monitoring (i.e., coverage was probably compromised by coincident monitoring of frequencies from other telemetry projects), and weather factors that reduced the duration and/or effectiveness of some flights.

We relocated two plovers (CRD 1 and CRD 2) at the Copper River Delta in 2001. From this stopover, situated well to the east of the nesting range, each bird moved westward and was detected again—CRD 1 to the south of Kotzebue, and CRD 2 to the south of King Salmon. Assuming straight-line distances, these flights were about 1,100 and 750 km, respectively. Ten plovers (including CRD 2) were found along the western edge of the Alaska Peninsula and west of King Salmon (Fig. 1). One set a record of 70 hr elapsed time

between our last contact with the bird on Oahu and its relocation in Alaska. Following its detection south of King Salmon, this bird then moved northward to breeding grounds near Kotzebue. In the Kotzebue survey area, we found six radio-tagged plovers, including the aforementioned 70-hr individual and CRD 1.

Eighty-four percent of the sample population (46 of 55 birds) returned to Oahu during the first fall after banding and each bird re-occupied its previous winter territory. The return rate did not differ significantly ( $\chi^2 = 0.33$ ,  $df = 1$ ,  $P = 0.56$ ) from that of plovers that were banded, but not radio-tagged, at the same study sites (144 of 166, 87%; Johnson et al. 2001a). Of the nine individuals that failed to return, five were females and four were males. Based on all plovers we have radio-tagged (Johnson et al. 1997, 2001a; plus the present sample), there was no difference between the sexes among birds that did not return (10 of 65 males versus 8 of 50 females;  $\chi^2 = 0.01$ ,  $df = 1$ ,  $P = 0.93$ ).

## DISCUSSION

Relocation of two radio-tagged birds at the Copper River Delta from late April to early May 2001, and another individual in 1996 (Johnson et al. 1997), indicates that some Pacific Golden-Plovers migrating from Hawaii use the delta region as a refueling site. Whether this is an intended landfall or a deflection caused by prevailing winds during transoceanic passage is uncertain. Repeated contacts with the radio-tagged plovers at the delta suggested that their stays there lasted about 1 week. Following this stopover, both of the 2001 birds moved westward and each was detected again in tundra habitat where they may have been nesting (Fig. 1). The 1996 bird made a similar movement from the delta to the Nushagak River region, where it was detected in late May (Johnson et al. 1997).

Detection of 12 radio-tagged plovers in the King Salmon region (10 from the present study; 2 previously, Johnson et al. 1997, 2001a) from Port Heiden to the mouth of the Kvichak River (between 57° and 59° N) suggests that this part of the Alaska Peninsula is an important spring destination for birds wintering on Oahu. Some birds stopping here are en route to areas much farther north (as shown by one radio-tagged plover subsequently re-

located near Kotzebue); others may be in passage to less distant breeding grounds, such as the Nushagak River drainage (Fig. 1; Bennett 1996, Johnson et al. 2001a). It is also possible that some of the birds detected on the Alaska Peninsula are nesting there. During a 15 May–5 June 2002 shorebird survey at various sites on the peninsula, C. Wightman (in litt. 2002) “recorded Pacific Golden-Plovers performing display flights to approximately 57 degrees 30 minutes latitude,” essentially the same latitude where we received signals from several of our radio-tagged birds. The timing of Wightman’s observations strongly suggests that they represented breeding birds, but as yet no intensive nest searches have been conducted. If nesting is confirmed at that latitude, it would extend the breeding range at least 250 km farther south than currently recognized (Fig. 1; also see Johnson et al. 2001a).

The minimum flight time of 70 hr from Oahu to near Port Heiden on the Alaska Peninsula is the shortest interval thus far recorded (previously 90 hr, see Johnson et al. 1997) for the transpacific passage. Assuming a great circle route of approximately 3,900 km, this bird’s minimum flight speed was 56 km/hr. Given the high-speed flight characteristic of the species (Paulson 1993, Johnson and Connors 1996), the actual flight time was probably less and the speed greater than we recorded. Measurements of flight-time and speed are complicated by a number of difficult-to-resolve variables, including time spent in pre-departure staging, routes followed, and the interval between arrival and detection in Alaska.

The relatively high rates of fall returns confirmed earlier conclusions (Johnson et al. 1997, 2001a) that radio-tagging caused no apparent harm to the birds. While this is reassuring, it remains uncertain whether transmitters interfere in any way with the reproductive process. Both sexes returned at equal rates and this further substantiated past findings (in part from birds not radio-tagged) of no sex-related bias in mortality during the migration or breeding periods (Johnson et al. 1993, 2001a, 2001b; OWJ unpubl. data).

Our aerial surveys in Alaska covered a relatively small fraction (probably <10%) of the area in which Pacific Golden-Plovers either nest or likely stop to refuel. Nonetheless, we relocated 15 of 55 (27%) from 2001 through

2003 and 13 of 60 (22%) in previous years. Our findings suggest that a substantial portion of the birds wintering on Oahu breed in Alaska. Whether some fraction of Oahu birds breeds in eastern Siberia is unknown. Our data also suggest that plovers wintering on Oahu nest throughout the known breeding range in Alaska (Fig. 1). Similar linkages seem likely for plovers wintering elsewhere in Hawaii, but proof will require additional radio-tagging in other parts of the archipelago.

#### ACKNOWLEDGMENTS

The project was funded by the U.S. Fish and Wildlife Service, Hawaii Audubon Society, and private donors participating in Kolea Watch. The latter program (administered by the Hawaii Nature Center in Honolulu) provides educational opportunities for people of all ages interested in Pacific Golden-Plovers. Support for MAB was through a grant from the Prince William Sound Oil Spill Recovery Institute. Aircraft and radio equipment were made available by the U.S. Fish and Wildlife Service. G. Castagnetti and various officers and officials in the U.S. Air Force kindly provided access to plover wintering grounds on Oahu. Many people helped us in Hawaii with capturing and radio-tagging plovers, monitoring their migratory departure, and assisting with other elements of the project; we are especially grateful to A. Bell, G. Bodner, S. Gaisford, K. Gaisford, K. Gingrich, A. Jeffers-Fabro, A. Kienholz, J. Lee, E. Penn, M. Roney, L. Shapin, and S. Southworth. P. Bruner and A. Bruner assisted in recording the fall return of marked birds on Oahu. The following individuals were invaluable to the aerial survey efforts in Alaska: K. Becker, J. Bertrand, D. Cox, N. Gregory, A. Leppold, B. Meixell, T. Moran, T. O’Hara (deceased), M. Prehoda, and S. Ranney. We thank B. Andres, J. Bart, and N. Warnock for their helpful reviews of the manuscript.

#### LITERATURE CITED

- BENNETT, A. J. 1996. Pacific and American Golden-Plovers breeding in southwestern Alaska. *Northwestern Naturalist* 77:49–51.
- JOHNSON, O. W., A. J. BENNETT, L. ALSWORTH, III, L. A. BENNETT, P. M. JOHNSON, J. R. MORGARI, AND R. J. KIENHOLZ. 2001a. Radio-tagged Pacific Golden-Plovers: the Hawaii-Alaska link, spring destinations, and breeding season survival. *Journal of Field Ornithology* 72:537–546.
- JOHNSON, O. W., P. L. BRUNER, J. J. ROTELLA, P. M. JOHNSON, AND A. E. BRUNER. 2001b. Long-term study of apparent survival in Pacific Golden-Plovers at a wintering ground on Oahu, Hawaiian Islands. *Auk* 118:342–351.
- JOHNSON, O. W. AND P. G. CONNORS. 1996. American Golden-Plover (*Pluvialis dominica*), Pacific Golden-Plover (*Pluvialis fulva*). *The Birds of North America*, nos. 201–202.

- JOHNSON, O. W., P. G. CONNORS, P. L. BRUNER, AND J. L. MARON. 1993. Breeding ground fidelity and mate retention in the Pacific Golden-Plover. *Wilson Bulletin* 105:60–67.
- JOHNSON, O. W., N. WARNOCK, M. A. BISHOP, A. J. BENNETT, P. M. JOHNSON, AND R. J. KIENHOLZ. 1997. Migration by radio-tagged Pacific Golden-Plovers from Hawaii to Alaska, and their subsequent survival. *Auk* 114:521–524.
- PAULSON, D. R. 1993. *Shorebirds of the Pacific Northwest*. University of Washington Press, Seattle.
- WARNOCK, N. AND S. WARNOCK. 1993. Attachment of radio-transmitters to sandpipers: review and methods. *Wader Study Group Bulletin* 70:28–30.